RESEARCH ON PACKAGING AND CONTAINERS IN THE

U. S. DEPARTMENT OF AGRICULTURE

November 1958

Office of Administrator
Agricultural Research Service
United States Department of Agriculture
Washington 25, D. C.

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PRODUCT REQUIREMENTS FOR PACKAGING FRESH AND PROCESSED FOODS

Problem: The rate at which the quality of packaged fresh and processed foods deteriorate to a considerable degree depends upon the environment existing within the container. Food products vary widely in their reactions to different environmental conditions and too little information concerning the characteristics, properties and tolerances of these products is available to research workers, packagers and shippers to provide an adequate basis for the development and selection of containers in which the quality of packaged food products can be maintained satisfactorily during the marketing process.

Program: A continuing program of chemical and physical studies is underway to determine the respiration rate, moisture-temperature-gas tolerance and chemical and physical changes occurring in fresh and processed packaged food products. This research is carried on by the Western Utilization Research and Development Division, Agricultural Research Service, at Albany and Pasadena, California; and by the Biological Sciences Branch, Agricultural Marketing Service at Beltsville, Maryland; Fresno and Pomona, California; New York, New York; Harlingen, Texas and Wenatchee, Washington in cooperation with 6 industry associations and the Agricultural Experiment Stations in California and Oregon. About nine professional Federal man-years are involved annually.

Progress:

(a) Packaging Requirements of Frozen Poultry Products. Storage tests on commercially packaged cut-up chicken fryers indicated a wide variability in storage life and that with good packaging it was possible to maintain a satisfactory storage life of at least one year at 0° F. Since packages vary in permeability to both moisture and oxygen, studies were undertaken to determine the relative importance of these packaging factors on storage life of cut-up chicken.

Evaluations were made of odor of the thawed meat, flavor of the cooked meat, and flavor of the cooked liver over a 12 month storage period. In comparison with -30° F. nitrogen packed samples, chickens in vented cans with air and ice present developed significant off odor at +20° F. within 2 weeks, at +10° F. within 4 months, and at 0° F. within 8 months. In general, the first detectable differences were in odor, followed by differences in flavor of liver and meat. At +20° F., deterioration in liver flavor was detected at 2 months and in meat at 4 months, while at 0° F. differences in liver appeared only after 8 months and in meat at somewhat more than 12 months. In the case of liver, which deteriorates rapidly in texture and over-all quality even under excellent storage conditions, the 8 months' estimate is probably high.

The amount of oxygen available to the meat proved to have a major influence on storage life, particularly in regard to off odors at the higher storage temperatures. The rate of deterioration at 2 percent levels of

oxygen was greater than a nitrogen control after 2 months at /20° F., but less than that in the air packed sample. Within the observed storage life of the product in air at /20°, /10° and 0° temperatures, no difference was detected between air and air plus desiccant packed samples. While moisture loss affects appearance it apparently has no effect, direct or indirect, on odor or flavor. Liver deterioration was not as sensitive to the presence of oxygen as were odor and meat flavor.

The results indicate the beneficial effect of nitrogen packing, especially where the product is exposed to temperatures of /10° F. or higher. Flavor losses in poor packages are apparently related to oxygen availability rather than to moisture loss.

(b) Packaging Requirements for Shelled Walnuts. Since shelled walnuts are sensitive to the unfavorable effects of ambient moisture, oxygen, heat, light and other high energy radiations, strict limitations are imposed upon the choice of containers which may be used for the commercial marketing of the kernels. Recent research has made possible the stabilization of kernels so that satisfactory results are obtained when commercially available transparent plastic films are used for packaging. The shelf life of these kernels was extended four times by the adjustment of antioxidant-treated kernels to 3.5 percent moisture and packaging in Saran film. Under commercial conditions the quality of the stabilized kernels has been maintained for a year or longer. The anticipated shelf life of untreated kernels may be one month or even less under conditions that prevail in certain parts of the U. S.

Further work is in progress to determine the underlying causes and mechanisms of the development of rancidity and darkening as a basis for the development of improved procedures for the stabilization of kernels which would minimize packaging requirements. Basic chemical studies indicate that volatile carbonyl compounds, oxidation products of the oil in walnuts, are a primary cause of the development of rancid odors and flavors. Laboratory experiments have demonstrated that the removal of the carbonyl compounds by carbonyl absorbing substances will reduce the rate of rancidity development.

(c) Time-Temperature-Humidity Tolerance of Dried Fruits. Retail packages of five different dried fruits were stored at temperatures of 30°, 50°, 70°, and 90° F. and relative humidities of 40, 60, and 80 percent in heat sealed bags of K-202 Cellophane and chipboard cartons overwrapped with an aluminum foil laminate. At intervals, samples were withdrawn and analyzed for moisture content, total and reducing sugars, color, weight changes, and sulfur dioxide content. Subjective evaluations also were made for changes in flavor, texture, odor, occurrence of mold, and surface sugaring. The dried fruits stored at 90° F. and various relative humidities deteriorated severely at the end of $5\frac{1}{2}$ months. Conclusions regarding the relative efficacy of the two types of packaging can not be drawn at this time.

(d) Gas Permeability of Polyethylene Film. Two little is known about film specifications to meet product packaging requirements, particularly gas permeability rates, and the knowledge of the respiration requirements of fruits and vegetables under different storage conditions is limited. Some values are known for some produce and for some temperatures. A method has been evolved which may allow rapid estimation of other values for experimental film compositions. Work also has been directed towards the development of a reliable method for measuring the permeability of such films. Preliminary tests indicate some of the difficulties to be overcome.

The occurrence of brown core in pears has been shown to be related to the concentration of carbon dioxide in the ambient atmosphere. Commercially available polyethylenes, when sealed, are not sufficiently permeable to carbon dioxide for pear storage without danger of contributing to the development of brown core. A more permeable film must be developed or existing films perforated to minimize brown core development. Tests have shown that perforating film liners is a satisfactory method of preventing excessive build-up of carbon dioxide. Several types of polyethylene films possessing high air-permeability rates, allowed an accumulation of 3.1 to 6.1 percent carbon dioxide in poly-packed Anjous, and 7.4 to 10.8 percent in Bartletts. A level of 2 to 3 percent carbon dioxide is desired. None of the films tested have met these requirements consistently.

(e) Controlled Atmosphere Storage of Grapefruit. Investigations have been initiated to extend the storage period of Texas grapefruit by controlling the storage atmosphere. Pitting, rind breakdown and color fading are common types of storage deterioration. Since the work was started only recently no findings are available.

(f) Weight Loss of Fresh Fruits and Vegetables after Harvest. Studies were continued on the loss of weight of oranges, lemons, grapefruit and avocados during storage to obtain fundamental data useful for improved handling, storage and packaging. A report on weight losses of citrus fruits as influenced by various conditions is in preparation.

(g) Vitamin C Loss in Vegetables. Fresh, leafy, green vegetables are a rich source of vitamin C, but under adverse handling and packaging conditions this vitamin is lost very rapidly. Kale, collards, turnip greens, spinach, rape, cabbage, and snap beans were subjected to slow, medium, and rapid wilting conditions at temperatures of 32°, 50° and 70° or 75° F. Conditions favorable to wilting resulted in a more rapid loss of vitamin C at all temperatures tested. Vegetables that lose moisture readily and wilt appreciably tend to be more affected by low humidity, and lose vitamin C more rapidly than those resistant to wilting. But even those that wilt most readily are less affected by humidity than by temperature.

(h) Respiration Rates of Fruits and Vegetables. The accumulation of basic data on respiration rates of produce at various temperatures is useful in developing permeability requirements of packaging materials. Measurement

of rates of respiration of Texas fruits and vegetables were continued, including spinach, head lettuce, cantaloupes and onions.

Plans: Findings obtained in studies of frozen poultry packed in cans will be used as the basis for further research on the selection of film or film laminated packages suitable for commercial use. Chemical studies will be continued to determine the causes of darkening and rancidity in walnuts and other varieties of tree nuts. Storage studies of dried fruits held at low temperatures will be continued to obtain information on quality changes over extended periods which will provide more critical evaluation of the effectiveness of the two types of packaging used. Work on vitamin C content of vegetables as related to wilting and storage temperatures is completed except for the preparation of a manuscript for publication. Studies on respiration, water loss, controlled atmospheres, and permeability of packaging films will be continued.

CONTAINER DESIGN AND MATERIALS

Problem: Damage to containers and their contents often occurs during the shipment and handling of agricultural products. More information is needed by container manufacturers and shippers on the adequacy and performance of containers and packaging materials of known specifications under various conditions and on ways of improving the design, composition and construction of containers to obtain adequate strength with minimum weight at reasonable cost.

Program: A continuing program of physical and engineering studies to develop general principles of construction and use for boxes, crates, pallets and packaging materials and to improve the design and better utilize materials for containers is carried on at the Forest Products Laboratory at Madison, Wisconsin, in cooperation with Marketing Research Division, Agricultural Marketing Service, the Agricultural Engineering Research Division, Agricultural Research Service and the Department of Defense. About four professional Federal man-years annually are involved in this research.

Progress: During the year work was initiated to evaluate the weather resistance of commercial container-grade paper-overlaid veneer, to develop a possible new container material consisting of single-faced corrugated fiberboard bonded to each face of thin veneer, to investigate the feasibility of using particle board decks for pallets, to explore the performance of cleated-panel boxes to determine whether it is feasible to reduce sizes of some elements and to explore the possibility of using adhesives for fabricating and assembling wood boxes. The study was completed on the determination of the optimum placement of material in the various elements of corrugated board. Fundamentals of pallet design continued under investigation. The text of two bulletins was completed on crate design and on container nailing. It was found that only limited amounts, two to three percent, of the side panels of fiberboard boxes could be removed for ventilation without significant strength loss and even with this small percentage, large losses in strength were encountered when the holes were cut near the vertical edges of the box or close to the corners on a line with a diagonally opposite corner.

Plans: Work will be continued on paper-overlaid veneer as a possibility for use in picking boxes, on veneer-fiberboard combination with emphasis on rough handling and moisture resistance, on assembly of crates with adhesives and with single-pin fasteners, on adhesives for container assembly and fabrication, on bin pallets and on particle board as a decking material. It is expected that work can be completed on distribution of material in corrugated board and on ventilation. Studies will be started on treatments of fiberboard to increase its resistance to moisture and to high and low temperatures and on cleated panel boxes assembled with spring clips which permit reuse of the panels.

DEVELOPMENT AND EVALUATION OF IMPROVED CONTAINERS AND METHODS OF PACKAGING AGRICULTURAL PRODUCTS

Problem: Losses due to physical damage and spoilage during the marketing of agricultural products amount to millions of dollars annually. Some of this waste which occurs during shipment, storage and distribution may be reduced through the use of improved containers and better methods of packaging.

Program: A continuing program of biological, engineering and economic studies to develop consumer packages, shipping containers and packaging methods which will offer better protection to the product, and facilitate handling at reasonable cost is being carried on by the Biological Sciences, Transportation and Facilities and Market Organization and Costs Branches, Agricultural Marketing Service and the Marketing Division, Farmers Cooperative Service at Washington, D. C.; Beltsville, Maryland; and field stations at Orlando, Florida; Savannah, Georgia; Chicago, Illinois; East Lansing, Michigan; New York, New York; Houston, Texas; Wenatchee and Yakima, Washington; and Madison, Wisconsin, in cooperation with State Agencies and industry groups. About 29 professional Federal man-years annually are involved in this work.

Progress:

Dairy and poultry products

(a) Consumer Packages for Milk. Three case studies have been completed, one each in a large, medium and small milk plant, during which data were obtained on materials and equipment costs and labor and space requirements needed to package milk in conventional and new types of containers as well as the suitability in use of these containers for schools, mass feeding and other market segments. A report is being prepared on the adaptability of new containers for the school milk program.

Because full cases of bottles and conventional paper containers were comparatively heavy, all schools observed required the driver to uncase the half-pint containers and set them out in the school refrigerator. Cases of 18 tetrahedral half-pints were very light and schools accepted them without removal of the individual containers. As a consequence it required about 40 percent less time to deliver the tetrahedral half-pints and even less time for the dispenser cans.

A survey also has been made of nearly 200 milk bottling cooperatives to determine the experience with container sizes and types used for packaging milk, particularly as processing and distribution costs are affected. A report on this work is being prepared for publication during the year.

(b) Shipping Containers for Ice-Packed Poultry. Five different new containers are either under test or about ready to be tested in the poultry marketing channels. Three are full telescope boxes constructed from fiberboard corrugated material, laminated or impregnated with paraffin; one is fiberboard corrugated material laminated with polyethylene and one is fome-cor laminated with Kraft paper. Two test shipments have been made with one of the containers, in which the fiberboard corrugated material was impregnated with paraffin for water-resistance. The box is full telescope with four drainage holes, one in each corner. Size of the container is 22 by 16 by 8 inches and when packed, the usual contents are twenty-four 2- to 3-pound chickens and about 20 pounds of chipped ice. In the first test shipment, 250 filled boxes were moved by refrigerated truck 125 miles and 300 boxes in the second load went 120 miles. In general, the containers looked good and the chickens were not visibly damaged, but further tests, moved over a longer distance in summer temperatures, are needed for more conclusive evidence. Preliminary tests have been made by the producers of two other container types which are about ready for experimental shipping evaluation.

(c) Fiberboard Boxes for Shipping Frozen Turkeys. Five types of fiberboard containers are being evaluated for 12- to 14-pound and 18- to 22-pound turkeys; four of the boxes are full telescope and one is regular slotted. Four shipments, with each shipment containing approximately 50 experimental containers of each type have been trucked from Modesto, California to New York City.

The type of container damage most frequently occurring was creasing at the bottoms and tops, and concave tops, particularly where there was excessive headroom, ranging from 1 to 2 inches. Damage was less evident when the pack was tight and headroom ranged from 1/4 to 3/4 inches. Film damage was slight in all instances and no product damage was evident. None of the evidence thus far obtained is conclusive.

Fruits

(a) Apples. Two types of consumer packages were developed and evaluated for apples during 1957-58 season. Twenty-five carloads were shipped in one type of package--a molded pulpboard tray with raised pyramids in the middle of the package to separate the apples. The package was modified during the year to eliminate the sharp corners on the raised pyramids which were found to cause excessive bruising. The packages were completely overwrapped with 300-gauge semi-moisture-proof cellophane. A triangular shaped wrap was found to be most economical. A wrapping table was designed. It included a jig which facilitated efficient manual overwrapping.

The second package, a Triplet tray, was a molded pulpboard tray of the dimensions of a standard apple box. It was designed so that it could be cut into 3 consumer size trays upon reaching the retail store. These 3 trays could be sold separately, or placed one on top of another and

wrapped with a band of polyester film, to which a handle is attached. This tray should reduce packing labor costs, because it is adaptable to machine filling and it should reduce marketing costs because it furnishes the retailer with a consumer unit, thereby cutting cost of packaging at the retail stores.

Preliminary test shipments were made of this tray with small size fancy grade apples in an effort to determine the potential possibilities of promoting a large unit size package. The Washington Experiment Station conducted limited tests on the 3-deck Family-Pak in comparison with apples packed in poly bags and apples sold in bulk.

Four types of end-vented corrugated cartons were compared with non-vented containers to determine comparative cooling rate of tray-packed apples in these containers. The total area of the vents in each box ranged from 3 to 7 square inches. With only one end of each box exposed as normally would be found with tightly placed pallet stacks and air flow parallel with the box ends, no significant difference in cooling rate of apples was found between those in vented and non-vented containers and in neither container did perforation of trays affect the cooling rate. Location in the cold storage room had considerable effect on the cooling rate of fruit packed in fiberboard boxes, but it was not related to the use of vented and non-vented cartons. In pallet loads of fiberboard boxes a 1x4 upright between stacks increased the cooling rate by 16 percent over a standard solid load but a double chimney stack cooled slower than the standard solid stack.

Studies to evaluate diphenylamine for control of apple scald were continued. As in last year's tests, diphenylamine (DPA) was much more effective than conventional mineral-oil wraps. Diphenylamine wraps containing 1.5 mg. of chemical markedly reduced scald of Cortland, Grimes Golden, Arkansas, Delicious, Rome Beauty and Stayman apples. Dipping fruit in 1000 or 2000 ppm DPA gave almost perfect control of scald on these varieties. However, there was some skin burning and pitting on Grimes Golden and Rome Beauty, particularly with the higher concentration.

Determination and field testing of different methods of preventing movement of containers during transit, including use of load locking devices, and applications of slip-resistant materials or pressure-sensitive adhesive to containers used in shipments of apples from New England to southern states, was carried on in cooperation with the Maine Department of Agriculture, the Maine Agricultural Experiment Station, shippers of New England-grown McIntosh apples, and Florida receivers. The work during the last year resulted in identification of the particular load conditions and displacement that have resulted in damaged containers, fruit injury, and inadequate refrigeration during transit. There were 19 shipping tests observed during the first phase in December 1957, and 21 more during February, March, and April 1958. Findings thus far indicate the advantages of tight loading with containers of the same size arranged uniformly together in the load, vertical stripping of truck side walls, and provision for air channel space at rear of loads in order to maintain proper circulation and even temperatures throughout the loads.

Studies with sealed and perforated polyethylene box liners on 11 varieties of apples were repeated during the 1957-58 season. Results on scald control and keeping quality confirmed those previously reported. Less ripening occurred in fruit during storage at 31° F. in sealed film liners than in fruit stored without liners. Apples in sealed liners usually had less scald, while apples in non-sealed or perforated liners often had more scald than fruit stored without liners. The degree of scald control was closely related to the oxygen level maintained around the fruit. Three to 6 percent oxygen usually gave good scald control, whereas 7 to 12 percent only reduced scald without giving commercial control. Two-mil sealed polyethylene liners and some types of 1.5-mil polyethylene liners had inadequate gas permeability and seriously damaged the fruit. Films made of higher density (0.928) polyethylene resins were worse in this respect than low density (0.914-0.920) films. The main problem to expanded commercial use of polyethylene liners for gas storage of apples is the one of obtaining and maintaining desired oxygen and carbon dioxide levels. At present, optimum oxygen levels cannot always be assured; a fairly wide range in oxygen levels is likely within liners of any given type.

(b) Apricots. Limited cost and trade preference studies were made of 5 different types or dimensional sizes of apricot containers. The most common containers used for local distribution were the unlidded wood lug boxes holding 26 or 28 pounds. Apricots for Eastern and Middle-Western States were shipped in 12- and 14-pound lidded boxes. The studies indicated that the 28- and 14-pound boxes were cheaper on an equivalent pound basis than the 26- and 12-pound boxes, and in other respects were equally as good. During the 1958 season the Marketing Agreement Committee standardized on the 28-pound unlidded wood box for the local trade and the 14-pound lidded box for out of state shipments.

(c) Avocados. In an evaluation of the containers being used by the Florida avocado industry it was found that the presently standardized avocado containers were generally satisfactory and that unsatisfactory arrival condition of the avocados was more often due to the way they were packed into the container than to failure of the container itself. Therefore, it was recommended that the avocado shippers (1) use a generally tight pack which prevents the avocados from jostling together in transit, a cause of bruising; (2) leave some headroom between the fruit and the lid, or to use some type of compression pad to prevent bruising from overhead pressure; and (3) use a moderate amount of excelsior distributed along the sides and into the corners of the box. The containers were also tested by the Forest Products Laboratory, Madison, Wis., and although they found differences in the compression strength, they were all acceptable for the purpose of shipping avocados.

A few shipments of special containers, which were smaller in size, also were evaluated. No reason was found for recommending their adoption by the industry since they did not improve on the arrival condition of the avocados but did increase container and packing costs. The study

gave no indication that a container of any one type of material, that is, wood, fiberboard, or wirebound wood, would be beneficial to the Florida avocado industry.

Field testing of new handling methods and equipment to reduce transit damage extending through two avocado shipping seasons was carried on in cooperation with the Florida Avocado and Lime Administrative Committee. Initial investigations have been made of the shipping problems and plans covering suggested changes in container design. Loading techniques to reduce transit damage have been formulated for a series of over-the-road shipping tests to validate the merits of the proposed changes.

(d) Cantaloups. Three new types of cantaloup containers which were tested out-performed the standard jumbo crate in protecting the melons from bruising during transportation and marketing and in reducing the costs of packing, transportation, and refrigeration. Packing and transportation costs have been reduced as much as 7 cents per crate through use of a new fiberboard carton for melons. The container damage in shipments of cartons was less than one-fifth of that normally found in rail shipments of the old jumbo crates. A new wooden crate was found to reduce container damage about two-thirds during transit and melon bruising by more than half. A report on this work will be issued during the year.

(e) Cherries. During the 1958 cherry marketing season primary attention was given to the evaluation of loose-pack containers for cherries. It cost 38 cents for a 20-pound wood box and 25 cents for direct labor to pack the cherries into it, a total of 63 cents. This compares with the 15-pound double row faced box costing 40 cents and with a labor cost of 50 cents, a total of 97 cents. Thus the conventional 15-pound double row face box cost about $3\frac{1}{4}$ cents more per pound of cherries.

In 18 shipments inspected on arrival in the terminal markets to determine the condition of the cherries packed in the 20-pound loose boxes and in 15-pound double row face boxes, there was no great difference between the condition of the cherries packed either way. Excessive bruising damage was generally associated with overpacking. Wholesale trade acceptance was much improved for the loose pack cherries over that in previous years. This undoubtedly was due to the efforts of the Cherry Marketing Agreement Committee to tighten up on the size and quality requirements of the loose packs.

A number of test shipments also were observed on a new consumer package for fresh cherries, a polystyrene tray. Eight of these trays were packed in the uncovered fiberboard box, commonly used for shipping strawberries. A number of the plastic trays were broken and the wholesale trade reaction in auction markets was generally unfavorable, primarily because of poor appearance, and stacking, handling, and pilferage problems. It is possible that some way of placing a lid over these containers would be one means of improvement.

(f) Citrus. Former users of the 1 3/5-bu standard citrus crate have shifted to the 4/5-bu. wirebound crate or to 4/5-bu. ventilated telescope cartons. The principal objection to cartons for Florida citrus has been their slow rate of cooling and the accompanying increase in decay. The introduction of the 4/5-bu. wirebound crate, which costs 5 cents more than the carton, prompted shipping tests to determine relative cooling rate of citrus in the two types of containers. This work has not progressed far enough to report findings.

Studies also were initiated to determine the effect of storing mid-season grapefruit in 1 1/2- and 3-mil sealed polyethylene liners for 14 weeks at 40° F.

Polyethylene consumer bags now are used to an increasing extent for packaging Florida oranges shipped in master cartons. Decay has frequently been reported to be higher following shipment in the film bags than in open-mesh consumer bags. This year test packages of hydrocooled oranges in 5-lb. polyethylene bags with 48 7/16-inch ventilation holes and comparable test packages of fruit in open-mesh bags were placed in 9 truck loads going to northern markets. All truck loads arrived in excellent condition regardless of the method of packaging; but after a 1-week holding period at the market, there was considerably more rind breakdown and green mold decay in the polyethylene bags than in mesh bags. It was found that perforating polyethylene bags with 100 1/4-inch holes per 5-lb. bag resulted in less decay than with 28 1/4-inch holes.

(g) Cranberries. Studies were made on the shelf life of Massachusetts-grown cranberries under various retail store conditions. One-pound vented cellulose-acetate window boxes and one-pound vented cellophane bags were displayed in the following retail methods: non-refrigerated, non-refrigerated daytime and in 40° F. room at night, crushed ice continuously with the packages separated from ice by kraft paper, false-rack mechanically refrigerated continuously, and mechanically refrigerated continuously. Deterioration due to weight loss, shriveling, and decay was progressive with time, but the amount differed with the method of display. Cranberries displayed without refrigeration lost an average of 6.8 percent in weight while those displayed under refrigeration lost 2.9 percent or less in 14 days. Total wastage (shriveling plus decay) was greater in cellophane bags than in window boxes. Total wastage ranged from 6 to 10 percent in 3 days and reached 15 to 50 percent in 8 days. Total losses under the best of the methods (mechanically refrigerated case continuously) reached 44 percent in 21 days. Losses under the poorest method (non-refrigerated continuously) reached 87 percent in 21 days. These studies emphasize the need for retail refrigeration and rapid movement of cranberries.

Three lots of Massachusetts-grown Howes cranberries, harvested from the 1957 crop, were stored in field boxes and prepackaged in master cartons for various periods up to 19 weeks in cold storage at 40° F. and compared with fruit kept in simulated common storage.

(h) Grapes. Eight different consumer packages were packed and shipped under commercial conditions during the 1957 season. They were (1) acetate film window cartons with stapled recessed bottoms; (2) acetate film window carton with self-locking bottom; (3) tray overwrapped with cellophane or cellulose acetate; (4) acetate film window carton with self-locking ends; (5) acetate film window carton with cover self-locking on side; (6) polyester film window carton with self-locking end; (7) tray overwrapped with cellophane; and (8) folding carton basket.

About 200 cars of packaged grapes were shipped in 1957. Cost of prepackaging the grapes averaged about 45 cents to 60 cents more per equivalent lug box than to pack them in bulk. The grape shippers received approximately 50 cents more for the prepackaged grapes. About 2 to 2½ percent of the prepackaged grapes were bruised or discolored when inspected on display in retail stores and about 2 to 3 percent shattered grapes were in the consumer packages. Previous studies showed that waste and spoilage losses average about 7 percent for grapes retailed in bulk containers.

Previous work also has shown that polyethylene liners can be used for packaging storage grapes if sufficient ventilation is provided to permit sulfur dioxide to diffuse into the package during the regular fumigation procedure. Studies were continued to determine the best fumigation method for perforated liners.

(i) Peaches. A cell type consumer carton holding 6, 8, or 10 peaches was evaluated during the 1957 season by packaging and marketing about 60 carloads of peaches from North and South Carolina in this package. The consumer packages and master shipping containers cost about $1.00 as compared to 52 cents for the conventional 3/4-bushel basket. Direct packing labor cost was 17 cents as compared to 6 cents for the 3/4-bushel basket, making the total labor and material cost for prepackaging the peaches $1.17, as compared to 58 cents for bulk packing. However, an average price premium of 73 cents was received for these prepackaged peaches in 1957.

A total of 34,000 questionnaire cards were inserted in the cell cartons in order to locate any widespread consumer complaints concerning the package or the peaches. Nearly 3,000 cards were returned--92 percent liked the prepackaged peaches; 88 percent said the peaches were in good condition; and 98 percent said the package was not damaged. During the 1958 season this consumer package and 4 new packages were evaluated in a peach packing plant in Arkansas. Two of the new packages were also cell type consumer cartons of slightly different design. The third new consumer package was a plastic tray overwrapped with polyethylene film, and the fourth was an acetate film-window carton. Operators of the peach packing plant in Arkansas and their primary sales outlet--a large grocery chain--both preferred the acetate film-window carton from the standpoint of ease of packing, protection to the peaches in transit and ease of handling and salability in retail stores. A packing line was developed.

During the 1958 season 24 truck tests also were made of which 8 were upright loads. A preliminary review of the results of these tests indicates that the inversion of alternate baskets permits an increase from 5 to 10 percent in the number that can be carried in a truckload (depending partly upon state laws governing permissible loads) without increasing the probability of damage. No appreciable effects on costs of loading or unloading have been found.

(j) Pears. During the 1956-57 season, experiments in the prepackaging of fresh Anjou pears were undertaken under a contract with the United Fresh Fruit and Vegetable Association. Three service wholesalers ripened and prepackaged fresh Anjou pears at the wholesale level. It cost about $3\frac{1}{2}$ cents a pound more to prepackage the pears at the wholesale level and distribute them to retail stores than it did to handle pears in the conventional bulk containers. The development of more efficient methods of prepackaging pears by service wholesalers did not look hopeful and this phase of the experiment was discontinued.

The program was revised to provide for experimentation with the prepackaging of pears at the point of production in Washington State during the 1958-59 pear marketing season. They will be prepackaged in molded pulpboard trays with raised pyramids and shipped along with comparable pears packed in standard wood boxes to selected wholesalers who each will ripen the pears and distribute them to a specially selected group of 10 retail stores. Studies will be made in these retail stores to determine the comparative salability of the prepackaged pears and the bulk pears along with waste and spoilage losses, labor requirements, and costs of retailing. Determination of the feasibility of mechanically packing Anjou pears in molded pulpboard trays was undertaken in cooperation with the Oregon Experiment Station in 1957-58. Two test shipments were made and were evaluated upon arrival in the New York markets. Substantial reductions were found in the cost of labor to pack the pears in molded trays by the use of a machine which enabled rolling the pears into the trays and lowering the trays into the shipping containers. However, the pears jostled about somewhat in transit, causing considerable discoloration and seriously impairing appearance and salability.

In cooperation with a Medford, Ore. packer, two test shipments were made in which fresh Anjou, Comice, and Bosc pears were jumble-packed in fiberboard boxes and in paper-wood-veneer boxes, as recommended for Bartlett pears by the California Experiment Station. On both boxes the lids were stapled into a fixed position prior to shipment. Excessive skin discoloration was found on Anjou and Comice pears on arrival in New York. Bosc pears arrived in excellent condition and were not discolored. The possibilities of reducing packing labor requirements for Bosc pears are very good, although more experimentation will be needed before Anjou or Comice pears can be jumble-packed.

(k) Strawberries. Two additional tests on packaging strawberries in different types of pint-sized trays using different kinds of film as caps or over-wraps were carried out in a continuation of the work started in 1956. The results under both refrigerated and non refrigerated conditions confirmed those obtained in previous tests. In general, decay was less in the open topped or over-wrapped trays than it was in trays that had film caps. Decay was greater in trays having polyethylene caps or over-wraps than in any of the other films tested. Semi-moistureproof types of film caps were the most satisfactory. Non-moistureproof types allowed excessive drying of the berries and moistureproof types allowed poor visibility because of condensation.

Vegetables

(a) Asparagus. In the State of Washington, experiments were undertaken during the 1958 season. Asparagus was trimmed to the edible portion and packaged in film packages. Seven-inch asparagus stalks were trimmed to 5 inches representing a 35 percent reduction in weight of the product. This trimmed portion represents considerable potential savings in shipping weight and space requirements. Costs and methods studies were made to assist the cooperating asparagus growers and shippers in setting up a more efficient operation. In five test shipments to nearby cities in the Northwest the packaged asparagus remained in good salable condition in retail stores in refrigerated cases from 5 to 7 days after it was received at the warehouse. The reaction of retail store operators was favorable.

A limited survey also was made of a commercial experiment in New Jersey in which the asparagus was trimmed to 5 inches in length, hydrocooled and packed into waxed trays and overwrapped with cellophane. The asparagus was merchandised through a corporate grocery chain which reported favorable sales.

(b) Cauliflower. The cost of trimming and prepackaging fresh cauliflower as compared to packing untrimmed cauliflower in bulk was determined in 7 California plants in the spring of 1958. The average cost of packages, master containers, and related interior packaging materials for prepackaging cauliflower averaged around 60 cents for 12 heads as compared to 40 to 50 cents for a bulk container and materials. Labor costs for trimming and prepackaging cauliflower was about 19 cents per dozen heads as compared to 11 cents for packing bulk cauliflower. Complete data have not yet been obtained indicating the total cost of marketing cauliflower from the farm to the consumer in consumer packages, as opposed to bulk, although it appears that prepackaging cauliflower should reduce total marketing costs through elimination of the considerable volume and weight of wrapper leaves involved in bulk shipment. One large corporate chain reported that it saved about 6 cents a head in refrigeration and transportation costs for prepackaged cauliflower.

(c) Chili peppers. Studies were continued to improve present methods of storing and packing dried chili peppers. The moisture content of the pods increased 4 percent when lots in large polyethylene bags were exposed to high relative humidity (90 to 95 percent) at 40° F. for 4 months. Similar pods packaged in close-woven burlap bags (the present commercial package) increased in moisture content 60 percent. Chili peppers exposed to low relative humidity (40 - 50 percent) at 40° F. decreased 14 percent in moisture content in the film bags and 58 percent in burlap. No.moldy pods were found under either high or low humidity storage conditions in the polyethylene packages. In burlap all the pods were unsalable after 4 months in high-humidity storage, due to excessive mold growth. Under low-humidity conditions the pods of test lots in burlap were excessively brittle and of poor color. Polyethylene liners in burlap bags appear to be an improved package for storing dried chili peppers for spice manufacturers.

(d) Dry beans. Packaging tests at Beltsville, Md. and E. Lansing, Mich., were initiated to determine if shelf-life of pinto beans can be extended by protective films. Twenty types of transparent films were exposed to ranges of 150 to 325 foot candles of light over a 6-week period.

(e) Leafy vegetables. Studies were continued at Beltsville, Md., to determine the maximum storage life of cabbage, celery and lettuce at various temperatures and in different types of packages. Evaporation losses were greatly reduced through use of polyethylene crate liners. Moisture losses of up to 36 percent occurred in celery in unlined crates during 8 weeks' storage at 32°, 38° and 45° F., but did not exceed 2 percent in polyethylene-lined crates.

Tests were conducted aboard a Navy supply ship during a regular replenishment tour of the Sixth Fleet in the Mediterranean Sea. Using cabbage, celery, and lettuce from the ship's regular cargo, it was found that the use of polyethylene liners retained the quality of these vegetables longer and increased their storage life. The value of trimming lettuce before storage also was demonstrated.

It was found in tests involving 200 commercial carloads of lettuce that, regardless of containers used, overpacking the lettuce always resulted in serious bruising. A study of the relationship of the tightness of the pack and the extent of bruising to the lettuce indicated that a weight space ratio of between 1.40 and 1.50 pounds of lettuce per 100 cubic inches of container capacity might be the best for a single standardized container. Whenever more than $1\frac{1}{2}$ pounds of lettuce was packed per 100 cubic inches of capacity of container, wrapper leaf and head leaf bruising was materially increased.

(f) Potatoes. Effects of precooling Kern County, California, potatoes were studied. Precooling loaded potatoes with railway car fans resulted in irregular cooling of both corrugated carton and burlap

bag loads. During 2 1/2 hours of precooling, tubers in the top layer of a carton load cooled 19 degrees while those in the bottom layer did not cool at all. Potatoes in a bag load cooled 15 degrees in the top layer and 4 degrees in the bottom layer during a 4-5 hour precooling period. Hydrocooling potatoes in a commercial washing vat in which the temperature was maintained at 70° F. removed an average of 9 degrees of field heat when initial pulp temperatures were 94°. The tubers remained in the tank from 3 to 26 minutes.

No new work was done on evaluating floor pads for transit protection of potatoes, but results of previous work were published.

Fifteen test shipments were made in 1957 of California Long White potatoes packed both in 50-pound fiberboard boxes and in 100-pound burlap bags. Twenty-one percent of potatoes packed in burlap bags were skinned and discolored as compared to 11.2 percent in fiberboard boxes; 14.9 percent of potatoes packed in burlap bags were bruised as compared to .5 percent in fiberboard boxes. Although most of this bruising was slight bruising, both the bruising and discoloration seriously affected the appearance and salability of the potatoes. Improvement of its appearance at retail level should greatly stimulate consumer demand for this early potato. The trade acceptance of fiberboard boxes was very favorable, particularly because the boxes protected the potatoes from bruising and greening. However, it was found that it cost the potato growers and shippers about 51 cents more to market their potatoes in fiberboard boxes as compared to 100-pound burlap bags. At the time this study was made in 1957, potato shippers demanded and received a 50-cent price premium for potatoes packed in fiberboard boxes. Fewer California Long White potatoes were packed in fiberboard boxes in 1958 due to their generally poor quality. This frequently made the potatoes discolor and deteriorate and the trade was reluctant to go to the additional expense of packing them in the more expensive containers.

Three test shipments were made in 1958 to evaluate the prepackaging of California Long White potatoes in 10-pound poly bags as compared to paper mesh-window bags. The paper mesh-window bag offers better ventilation to the potatoes and they are not generally packed in master containers. Polyethylene bags, due to their moisture impermeability, theoretically should reduce shrinkage losses of potatoes in transit, and should promote increased sales due to the superior visibility of these premium type potatoes in transparent film. Only 3 test shipments were made because of the poor or uncertain quality of the 1958 California potatoes. One of these 3 shipments showed considerable decay upon arrival and the decay was greater in poly bags than in open mesh-window bags. On the average, though, there was not much difference between the amount of bruising, skinning, decay, and greening of potatoes shipped in these 2 packages. There was about 2 to 4 ounces less shrinkage of potatoes shipped in poly bags than those shipped in paper mesh-window bags. Observations made at 5 retail stores indicated that greening of potatoes in poly bags was a minor problem. Slight greening was found to average .8 percent of the potatoes packed in poly bags as compared to .4 percent for potatoes packed in paper mesh-window bags.

(g) Radishes. Cracking of radishes marketed in film bags has been a problem in some shipments. Studies to determine whether cracking was increased by hydro-cooling topped radishes before packaging were initiated on two spring crops of the Cherry Belle variety.

(h) Sweet corn. In preliminary studies during the summer of 1958, fresh sweet corn was husked, hydrocooled and prepackaged in acetate window cartons -- 6 ears of corn per carton. The corn was packed into master containers and delivered to a chain store warehouse in the Philadelphia area. Acceptance was good; sales of the prepackaged corn were reported very satisfactory at 35 cents a package of 6 ears. Assistance was given to the container manufacturer in the development of this package and to the packager of the corn in developing a more efficient operation.

Fibers

(a) Cotton. During the year a study was made in cooperation with Farmer Cooperative Service covering the past two seasons, of the cost and efficiency of packaging and marketing cotton bales pressed at selected gins in Arizona and California by means of conventional low density presses compared with the newer higher density presses requiring no further compression for domestic shipments, an analysis was completed with the assistance of the National Cotton Council, of the effects of the bale package on the 1956 preprocessing practices and costs of domestic mills, investigations were conducted in cooperation with Foreign Agricultural Service with considerable assistance from the National Cotton Council, of the added costs and other effects, resulting from the major shortcomings of the American bale package as our cotton moves from selected domestic locations to, and is stored and used in some of the largest of the foreign markets for American cotton, and a study, also in cooperation with the Farmer Cooperative Service and based mainly on 1956-57 and 1957-58 experiences, was initiated on the advantages and disadvantages of automatic sampling of cotton during the ginning process compared with cut sampling.

Collection of data has been completed on the comparative compression cost study and should be completed on the bale sampling study this year. Tabulations of the data for both these studies are under way and reports should be completed early in 1959. The work on the costs and other effects of the shortcomings of the American bale package as related to export markets was only initiated in the summer of 1958. The final report on the effects of the bale package on the preprocessing practices and costs of United States mills indicated that in 1956 these costs were approximately 33 cents per bale consumed. Preprocessing cleaning costs were estimated at 25 cents per bale for the approximate 51 percent of the bales cleaned, and were equivalent to 13 cents per bale for all bales consumed. The estimates of other costs which were not limited to the bales cleaned, were equal to 20 cents per bale consumed.

Plants and Seeds

(a) Rose bushes. Research conducted in previous years on packaging rose bushes demonstrated the efficacy of polyethylene liners and certain

fungicides in maintaining quality in bare-root rose bushes during storage. Current studies have been directed toward commercial application of these findings. Nearly 1,500,000 rose bushes were stored by these new methods in the 1957-58 season.

Weight loss was less in bushes stored in a container with a liner made of kraft paper coated with polyethylene than in a corrugated carton coated with polyethylene. The latter container did not provide a continuous protective film around the plants because of seams in the carton and a lack of uniformity in the film coating. Atmosphere modification also was greater in the packages with the separate liners than in the coated cartons. When packages with liners of kraft paper coated with polyethylene were held at room temperature for 4 days after storage, considerable modification of the atmosphere occurred. Liners should be ventilated when removed from storage. Both types of packages cooled at about the same rate when placed in storage.

(b) Strawberry plants. The recent extension of the storage life of dormant strawberry plants through use of polyethylene liners, has made later plantings of good quality plants possible. There is little if any information on the response of cold-storage plants to June and August plantings in Eastern United States. Eight commercial varieties set June 1, 1957 at Beltsville produced yields ranging from 10,000 to 13,000 quarts per acre. Such yields are five times the average commercial yields for plants set in March-May in this area.

(c) Tomato plants. Tests were continued to evaluate polyethylene bags and crate liners as packages for shipping bare-rooted tomato transplants from Georgia to Northern production areas. Four refrigerated truck shipping tests, (3 ice bunker and 1 mechanical), conducted in cooperation with the Campbell Soup Company were made from Cairo, Ga., to Woodstock, Ontario, Canada.

(d) Seed. Samples of Kentucky blue grass, red fescue, cabbage and onion seed were stored at 3 moisture levels (3, 5 and 7 percent) in 9 kinds of packaging materials, at 5 temperatures (33° F., 50°, room, 80°, and 110°). Packages of each type at each temperature will be withdrawn at 90-180 day intervals over a 3-year period for examination.

Cross-Commodity Studies

(a) Insect-resistant packages

Preliminary laboratory repellency evaluation tests were conducted with 254 compounds which had shown some promise against other groups of insects. Three of these compounds showed sufficient repellency to flour beetles to warrant immediate followup studies. These were N-methylphthalmide (ENT-1393), N-ethylphthalimide (ENT-1394), and malononitrile, 1-cyclopropylethylidene (ENT-16838).

New samples of N-pentylphthalimide have failed to show the outstanding repellency demonstrated by the first sample. The chemists are investigating the synthesis of the various samples to determine whether the first was chemically different than the last two samples tested. Candidate repellent compounds which have shown promise in the preliminary evaluation program are being tested further as clay-slurry formulations applied to small paper bags and exposed under storage conditions to a heavy stored-product insect infestation.

Laboratory tests have shown malathion to be quite persistent when applied to paper in a clay-slurry formulation and, therefore, small-bag evaluation tests were started to determine the effectiveness of this material in preventing insect infestation of packaged commodities.

Cooperative storage tests involving the dried-milk and container industries are in progress at the Madison, Wisconsin, and Savannah, Georgia, laboratories on the evaluation of several insecticide treatments and a number of structural differences in packages, to determine their ability to prevent insect infestation of bagged powdered dry milk.

Field storage tests are being conducted in cooperation with members of the seed and container industries to determine the degree of protection against insect infestation during storage that will be provided by treated bags used for seed corn and sorghum. The treatments being tested are pyrethrum plus piperonyl butoxide, methoxychlor, and a combination of all three.

Large-scale storage tests are being conducted in cooperation with members of the paper, container, and chemical industries and the Millers' National Federation on the protection against insect infestation rendered by lindane-treated bags, and on the effectiveness of an aluminum-foil barrier sheet to prevent migration of the insecticide into the commodity inside the package.

Storage tests conducted in cooperation with a member of the food processing industry on the evaluation of several experimental closures on shell cartons strongly indicate that these closures are far superior in preventing insect invasion to the type of closure commonly used by industry.

The natural resistance to insect penetration possessed by a number of packaging films has been determined. It was found that none was completely insect-proof and that the resistance varied with the different films. A polyester film showed the greatest resistance to insect penetration.

Studies are in progress on the effect of various paper-coating additives such as clays, resins, latices and adhesives on the repellency of synergized pyrethurm. None tested to date has had a beneficial effect on the degree or persistency of the repellency of synergized pyrethrum.

(b) Procuring containers and packaging supplies. A series of case studies of the experience of farmer cooperatives and other marketing agencies in procuring containers has been initiated. An analysis of possible ways to further coordinate procurement and transportation of containers and packaging supplies by farmers and marketing agencies will be made to develop more efficient methods. This work has not progressed to the findings stage.

(c) Prepackaging in centralized packing plants. A survey has been completed of the extent of use of various types and sizes of consumer packages and master containers, operating practices, and characteristics of special packing plants in the centralized or terminal markets. The 217 plants included in the study were found to be prepackaging 50 different commodities. In general, polyethylene bags were found to be used for root crops and apples and citrus fruits; cellophane and polyethylene were used for the packaging of green and leafy vegetables. Window cartons and trays were frequently used for small fruits, such as grapes, berries, cranberries, and tomatoes. A report has been prepared for publication showing details of types and size of packages used, machinery and equipment used and cost of labor to prepackage each commodity.

Plans: Dairy and Poultry Products

The preliminary report now in preparation on consumer packages for milk will be completed and additional information will be obtained from a large sample of schools and the dairies supplying them. Studies to evaluate containers used in other segments of the mass feeding market in which requirements differ from those in schools will be expanded.

Work will be continued with processors, distributors, and container manufacturers in evaluating new materials for use in constructing shipping containers for ice-packed poultry, and further experimental shipping tests of these containers will be initiated for the purpose of making an economic evaluation of container performances and quality preservation.

The study of evaluating new and conventional shipping containers through test shipments of frozen turkeys from other points of origin and destination will be continued. Shipments from the first processing plant are scheduled to be completed by the end of 1958. It is planned to evaluate and analyze the data and prepare a manuscript for publication in 1959.

Fruits

The molded pulpboard pyramid tray for apples will be further evaluated during the 1958-59 season and the molded pulpboard triplet tray will be further modified and also evaluated during the coming season. If both packages continue to show promise, plant layouts and methods of packing them will be developed in cooperation with cooperating apple packing plants.

After completion of field work on methods of preventing movement of apple containers during transit this season's results of the shipping tests will be analyzed, and a report prepared.

Additional consumer packages which appear promising for apricots will be evaluated.

No work is planned to further develop or evaluate improved containers for avocados at this time but comparative evaluation tests of truck-trailer shipments of avocados and limes are schedules for the 1958-59 season.

Work will be continued to determine to what extent the shipping of loose-packed cherries and consumer packaged cherries is advantageous to the cherry growing industry.

The cranberry study is completed and a report has been submitted for publication.

The work is continuing on precooling tests of various containers and loading or storing patterns for apples and citrus. Studies with DPA for scald control of apples will be continued with emphasis on development of the most feasible method of application and elimination of injury due to the chemical.

The work will be continued on grapes to further evaluate these consumer packages and master containers and to assist cooperating grape prepackaging plants to set up more efficient packaging operations.

None of the consumer packages evaluated thus far was completely satisfactory for prepackaging ripened peaches. It is planned to continue this work by cooperating with container manufacturers in developing improved packages and testing them under commercial conditions in cooperation with peach packing plants, and to assist peach packing plants in developing more efficient packaging operations.

It is planned to continue the experiments on prepackaging pears at point of production and to develop efficient methods of packaging them to reduce the total cost of marketing, if tests now being conducted indicate they can be delivered in good condition. Further studies are also planned by the Oregon and California Experiment Stations to test the possibilities of reducing packing costs by semi-mechanically packing the pears in trays, and jumble-packing them in fiberboard boxes.

Consumer packaging studies with cranberries and strawberries are completed and the results will be published. Blueberry consumer packaging and storage studies are being initiated.

Further shipping tests of hydrocooled oranges in perforated polyethylene bags packed in master containers will be made for comparison with non-precooled oranges in open-mesh bags.

Vegetables

It is planned to continue research on asparagus prepackaging another year to evaluate alternative packages and methods of prepackaging asparagus, and to determine the economic feasibility of prepackaging asparagus at the point of production. Master shipping containers also will need to be developed to assure delivery of prepackaged asparagus in good condition at the least possible expense.

The work on cauliflower will be continued with emphasis on determining which type of consumer package, master container, and packaging operation is the most efficient and least costly, and also to determine the condition of cauliflower in various types of packages upon arrival in terminal markets and retail stores.

No further work is planned on dry beans, chili peppers or leafy vegetables at this time. Reports covering results are being prepared.

It is planned to continue the research program of evaluating the possibility of prepackaging potatoes at point of production as a means of maintaining the quality throughout the marketing system and reducing the labor cost of repackaging the potatoes at the wholesale or retail level.

Tests with packaged radishes will be repeated to see if during a dry growing season post-harvest cracking is more severe.

It is planned to continue work on sweet corn to evaluate the economic feasibility of prepackaging fresh sweet corn at the grower level and deliver it to consumers in a satisfactory condition.

Fibers

It is expected that most, if not all, of two phases of the currently active work on cotton will be completed and closed out in late 1958 or early 1959. The field work relating the movement to and use of American bales in export markets should be completed during the winter of 1959 and a report of the findings issued in the spring or summer of 1959. If further contacts with industry representatives or others indicate it is desirable and feasible, a study will be made of the effects of the bale package on domestic mill processing costs and on the downgrading of yarns and fabrics, and such other domestic marketing costs as warehousing, compressing, and transportation.

Plants and Seeds

Packaging studies of bare-root rose bushes and strawberry plants are largely completed and the results widely adopted.

The seed packaging tests were recently initiated and those on tomato plants will continue along present lines with further trials of the more promising types of films or with additional ventilation.

Cross-Commodity Studies

The laboratory evaluation and follow-up testing of promising insecticides, repellents, extendors, and activators will be continued. The large-scale tests on the evaluation of insect-resistant packages conducted in cooperation with various industry members will be continued and expanded to take in more commodities than are now under test. Investigations will be continued on the improvement of formulations for treatments to be applied to packages to provide resistance against insect infestation. Studies on the evaluation of packaging materials and package construction will be expanded to include improving the physical insect-resistance of fiberboard shipping containers used for processed foods and dried fruit.

It is planned to conduct work on processing containers for fruits and vegetables in 1958-59 fiscal year with selected organizations in Florida and the western States. Similar studies will then be conducted in other areas in the 1959-60 fiscal year.

The survey of prepackaging operations in centralized packing plants has been completed.

RETAILING AND MERCHANDISING OF PACKAGED AGRICULTURAL PRODUCTS

Problem: High labor costs, waste and spoilage losses in retailing agricultural products in bulk have stimulated retailers to demand more and better packaging from their suppliers. Some products which are too perishable to be packaged very long before sale to consumers have to be packaged in the retail stores or in their distributing warehouses. Variation in size and type of retail operations make such packaging and handling operations costly unless improved methods, lay-outs, equipment and operating practices are developed which are efficient and adaptable to various size retail stores.

Program: Continuing economic and engineering studies are carried on by the Transportation and Facilities Research Branch, Agricultural Marketing Service to apply principles of work improvement, organization and layout in the performance of packaging functions in retail food stores and warehouses in various sections of the U. S. in cooperation with commercial firms. About 5 professional Federal man-years are involved in this work annually.

Progress:

(a) Prepackaging produce in retail stores. Methods and materials for packaging approximately 60 fruit and vegetable items at the retail store level were evaluated. Improvements were developed, evaluated, and recommendations made for packaging of the major portion of these items. In 4 supermarkets where intensive records were maintained improved packaging and price-marking methods resulted in weekly savings of from $22.00 to $67.00. Potential savings to the industry amount to several million dollars annually. Detailed studies of the relative merits of prepack and bulk operations were made.

(b) Warehouse packaging of produce. Improved retail produce packaging operations have been installed in 4 outlets and cost data from these outlets are being obtained for comparison with cost data developed in warehouse packaging. The warehouse packaging and retail store packaging costs of two "unimproved" operations have been obtained and are being analyzed.

(c) Wholesale and retail distribution of dairy and poultry products. Data have been collected for several additional operations for the purpose of evaluating present handling and packaging procedures for dairy and poultry products.

(d) Prepackaging meat and delicatessen items in the retail store and warehouse. An analysis of wrapping machines and wrapping aids for packaging fresh meats in the retail store has been made. Collapsible-type trays for displaying and handling meat items have been developed and tested on a limited scale. Improved computer scale installations have been made and analyzed for several inside and several outside label operations. These installations have been compared with conventional type operations. In cooperation with Purdue University and Federal Extension Service an improved meat installation was made and a color sound motion film planned and partially completed.

Plans: The major portion of the development of basic principles of work methods, organization, and layout in the store level prepackaging of produce has been completed and a report is being printed. The installation and evaluation of additional prepack and bulk operations will be continued to develop the relative advantages of the two major methods of handling produce. Studies to evaluate new packaging techniques and equipment in the stores will be made.

The packaging of selected produce items will be moved to the warehouse and the best operations developed for packaging these items. The cost of packaging with an improved warehouse operation will be compared with the costs of packaging in an improved store operation. In the two warehouses where extensive packaging is now being done attempts will be made to improve the operation. Results may be available on one or two principal produce groups by next year. It will take several years to cover all of the commodity items.

Present procedures in firms with the latest handling and packaging methods will continue to be studied. As soon as they have been evaluated and improved, these improved procedures will be installed in test stores where they will be further evaluated and tested.

Three more fully automatic wrapping machines, three more semi-automatic wrapping machines and several hand wrap meat packaging operations are still to be studied. Plans to complete the study on scaling await the final release by the manufacturer of an improved computing scale which is competitive to those already analyzed. As soon as this scale is released it will be tested and analyzed. The meat tray display work will be continued during the coming year. The film being developed with Purdue University will be completed.

CONSUMER REACTIONS TO PACKAGED FOOD PRODUCTS

Problem: Unfavorable consumer reaction to many packaged products may be due to limitations of size, shape, type of design of the package or to lack of confidence in the quality of the product packaged which results in reduced purchases and consumption of packaged foods. Deceptive packaging, misbranding, non-informative labeling or short weights, even though unintentional, also hurt sales of packaged products. More information on the preferences and attitudes of consumers regarding packaged commodities is needed as a guide in improving the packaging of agricultural products.

Program: A long-term program involving consumer surveys and in-store merchandising experiments is carried on in selected cities throughout the United States by the Market Development Branch of the Agricultural Marketing Service. The cities selected vary with different products. This research for the most part is conducted by the Department using about 3 professional Federal man-years annually.

Progress:

(a) Consumer reactions to food packaging. A survey of consumers' attitudes and opinions toward the packaging of canned and frozen foods has been completed. On the whole, consumers approved the standard containers used for both canned and frozen foods. They felt that canned foods can be stored indefinitely and are convenient and easy to store. Frozen food containers were found to be easy to open and dispose of. Homemakers particularly objected to the key-type can, finding it difficult or dangerous to open and hard to get the food out. Disposal of the can was also a problem because of bulk. The one important reference to the effect of the can on the contents was expressed as "contents get a peculiar taste over time."

The feature most disliked about frozen food containers was "a limited selection of sizes." Complaints were also registered to the effect that "the containers are flimsy," "not well packed," "the juice runs out." Other homemakers disliked the method of opening and found them hard to open. Once open, the food was found to stick either to the container or the paper wrapping.

The study further revealed that homemakers in the cities studied were not particularly well informed on the various items of label information which concern volume, such as can size, statement of contents, or number of servings. This seems to result from lack of interest rather than dissatisfaction, since most respondents felt that the existing sizes provide adequate choice in terms of the servings needed for their families.

The key label item for both canned and frozen foods as far as homemakers were concerned is brand name; package size and weight were far down the scale. Despite the importance of brand name, a substantial majority rejected the idea of a label containing only brand name and statement of contents.

(b) Effect of increasing variety of package sizes on sales of selected food items. The purpose of this research, conducted in Boston, Massachusetts, was to obtain additional data on the effect of increasing the variety of package sizes on sales of selected food items. For this experiment, unpitted dates were displayed in various package sizes in 3 verticle rows. The display containing the 3 sizes of packages (12-, 24-, and 32-ounce) resulted in 61 percent greater sales than the display of 12-ounce packages alone with an accompanying increase in display size of 25 percent. Sixteen to 21 percent greater sales were obtained by using 2 package-size combinations (12 and 24 or 12 and 32 ounces) instead of the 12-ounce package alone. Similar results were obtained in earlier experiments in testing variety of package size for other produce items such as apples and pears and for prepackaged cheese. When the 3 packages of dates were displayed together, a somewhat larger quantity was sold in the 12-ounce package than in either of the other 2 package sizes. A final report is expected late in 1958.

Plans: Retail store tests will be made of the consumer acceptance of selected store packaged produce items in the present overwrapped tray versus a newly developed and more economical sleeve wrap and the "home toter."

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